Non-literal Language Use and Coordination in Dialogue

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Abstract. Metonymies are known as ways of conceptualizing entities and situations of various sorts. For example, users of PCs usually call the icon depicting a waste paper basket 'basket'. They thus use the name of the depicted object for referring to the depicting object. We use a model airplane ("Baufix" airplane) as the paradigm case for investigating the semiotics of depictional metonymies and the role they are put to in construction dialogue. The airplane's structure is described in a GPSG format and given a model-theoretic semantics. We also describe how aggregates of the toy model are given depictional interpretations in the course of the construction dialogue. The coordinating role of metonymic language use is illustrated. It is also shown how cognition can be integrated into the model developed.

1 Motivation

In everyday talk as well as in scientific discussion people frequently use non-literal language (tropes). Tropes are taken as a manifestation of productive or creative language use. This is one of the reasons why the cognitive sciences, including AI, are interested in theories of non-literal language (cf. (Indurkhya 1992), (Way, 1991)), especially in theories of metaphor and metonymy. Before we describe the field we are interested in, i.e. metonymies based on depiction, we provide some examples of metonymies in general (the metonymic expression is underlined):

(a) <u>I</u>'m parking out back. *(b) <u>The DRT-box</u> is empty.* *(c) <u>The airplane</u> is built.*

Metonymies are based on certain relations which they ”exploit”. E.g., (a) uses a relation between the driver and the vehicle to refer to the vehicle with the first person pronoun *I*, in (b) the object called *box* is really a rectangle, hence one uses a relation between boxes' surfaces and rectangles to refer to a particular DRT-representation, and (c) is said of a toy-airplane, where a construction in ways yet to be explained licenses the use of the word *airplane*.

Many types of metonymies exist and there does not seem to be one single theory which can capture them all (cf. (Nunberg, 1995)). Example (c) is outstanding, since it exploits a relation between the toy in question and the class of airplanes. The example meets another current interest of the cognitive sciences, namely the interest in depiction (cf. (Sloman, 1971), (Glasgow et al., 1995), (Eschenbach & Kulik, 1997) and (Habel, 1998)). In order to refer to drawings, maps, pictures, models etc., we may use the names of the objects they ”are about”. Certain types of metonymies, we observe, are based on a relation of depiction, of ”being about” another object. These metonymies have an obvious application interest: Computer icons, e.g., are called folders, waste-paper baskets etc. or – with CASE tools – plants, objects and modules.

In our article we explain how the depiction relation for metonymies can be reconstructed and properly interpreted. Our investigation is based on a corpus of transcripts, speech recordings, video-films and eye-tracker data gathered in the context of the following experimental setting: An instructor has a toy airplane (called "Baufix" airplane) shown in fig. 1 in front of him. He instructs a constructor to build an airplane of the same type using another set of parts lying in front of him. Both agents are separated by a screen.

We use the example of the toy-airplane as a paradigm case for investigating depictional metonymies and their role in construction dialogue.

2 Semiotics of Depicting Aggregates

Depicting aggregates such as the toy airplane refer to real-world objects, and this reference depends on their compositional structure. Such aggregates must hence be seen as structured semiotic objects. Consequently, we have to specify their syntax, semantics and pragmatics.

2.1 Syntax

Our leading hypotheses for the syntax of depicting aggregates are:

1) Aggregates ultimately consist of elementary parts (”atoms”).
2) Aggregates are composed of atoms and of aggregates of lower complexity.
3) Aggregates are subject to well-formedness conditions concerning the connections of atoms and partial aggregates to each other.

Of the many syntax formats possible, we chose GPSG for flexibility. We will illustrate the syntax describing the structure of the tail of the "Baufix" airplane: The atoms available for its construction are three-holes bars $3ll_i$, five-holes bars $5ll_i$, a red holes cube lwr_1, a red round bolt ssr_1, and hexagonal bolts skr_i. The aggregate resulting from putting skr_1 through an end hole of $3ll_1$ will be denoted by $[_{X_1}\ f_1, 3ll_1, skr_1]$. Here, f_1 is a syncategorematic terminal symbol describing the special arrangement. The corresponding general grammar rule reads

$$R_1: X_1 \leftarrow f_1, 3LL, SKR,$$

where 3LL denotes the category of three-holes bars, SKR indicates the category of hexagonal bolts and X_1 names an aggregate of instantiations of these. Further rules are R_2: $X_2 \leftarrow f_2, X_1$, LWR; R_3: $X_3 \leftarrow f_3$, 5LL, SSR; R_4: $S \leftarrow f_4, X_2, X_3$. R_2 describes bolting a red holes cube onto an X_1-structure; R_3 describes forming an aggregate of a five-holes bar and a round bolt put through its middle hole. Bolting the round bolt of X_3 into the suitable hole of the cube in X_2 is described by R_4. This yields category S corresponding to the tail of the toy airplane. Further rules such as 5LL $\leftarrow$ $5ll_1$ describe instantiation of categories.

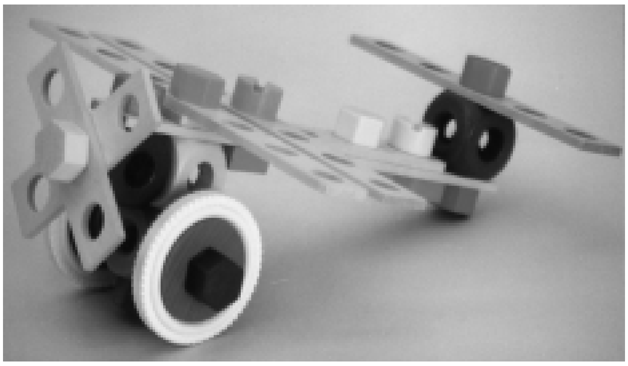


Fig. 1: "Baufix" airplane

2.2 Semantics

Here, our leading hypotheses are:
1) Semantics follows syntax (compositionality).
2) "Baufix" atoms denote themselves (autosemantics).
3) "Baufix" aggregates denote themselves or (parts of) real airplanes.

Hypotheses 2 and 3 reflect that dialogue agents do not conceive of isolated "Baufix" atoms as depicting entities. Only more complex aggregates such as given by S in 2.1 are seen as depicting.

Following these hypotheses, the domain of our models is sorted into "Baufix" atoms, "Baufix" aggregates and (parts of) real airplanes.

The interpretation function is a pair of two functions, mapping every object x to $<V_{Bf}, V_{ap}>(x)$, where V_{Bf} is the identity function and where the co-domain of V_{ap} is the set of (parts of) real airplanes. An object x is in the domain of V_{ap} if and only if it depicts (some part of) a real airplane.

We denote the meaning of an object x relative to a model $M = (U, <V_{Bf}, V_{ap}>)$ by $[\![x]\!]^M$. The meaning of, e.g. f_1 is $[\![f_1]\!]^M = \{<x,y>| \text{ x is put into an end hole of y}\}$. For "Baufix" atoms x, the meaning is the atom x itself, for elementary category symbols such as 5LL, it is the set of instances of the category. Furthermore, $[\![[_{X_1} f_1, 3LL, SKR]]\!]^M = [\![X_1]\!]^M$ is the set of all "Baufix" aggregates consisting of a hexagonal bolt put into the end hole of a three-holes bar.

Finally, the meaning of S is a pair <V, W>, where W consists of all tails of real airplanes. Intuitively, V contains all pairs <x,y> of the following sort: The first element x is an aggregate consisting of a three-holes bar and a red holes cube

fixed to the bar by a hexagonal bolt put through the bar’s end hole. The second element y is made up of a five-holes bar and a red round bolt put into its central hole. The relation f_4 captures the specific linkage between x and y.
Our approach accounts for the facts that only certain aggregates are named metonymically and that metonymic and nonmetonymic expressions can alternate.

2.3 How to Generalize the Approach

There are lots of toy models, all depicting planes. Even though models exhibit their relation to airplanes in different ways, they ultimately may be bound to the same extension. In this sense, the ”Baufix” airplane and the so-called ”Japanese” airplane in fig. 2 depict the same class of airplanes in contrast to the ”Lego” plane in the same figure depicting biplanes.
Why is it that models depict in the same way? The intuition accounting for that is that some of their parts fulfil a comparable role as regards depiction. This of course has to be captured by our syntactic description.

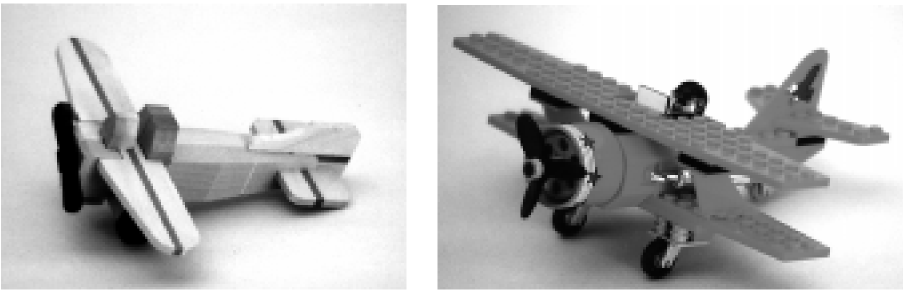


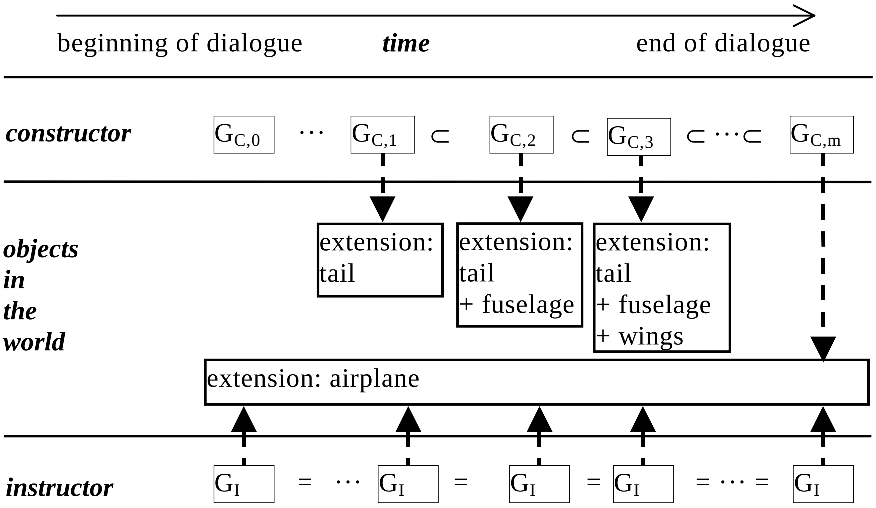
Fig. 2: ”Japanese” plane and "Lego plane“

We can achieve this target in at least two ways:
The first is to let the different models be generated by different grammars, more generally, to set up a set of admissible grammars and to constrain these grammars by a suitable filter. The second is to provide one single parameterized grammar. Details are given in (Rieser & Meyer-Fujara, 1999).
Both techniques will provide the same extension for the ”Baufix” airplane and the ”Japanese” one and weed out the ”Lego” plane.

2.4 Pragmatics: Introduction of Metonymies in Construction Dialogue

Based on the generalized approach to depictive metonymy in 2.3, we can map speakers onto their grammars. Hence, in order to explain why in a normal situation speakers can fairly homogeneously and successfully use "airplane" for different models, we must postulate that speakers use different grammars employing extensionally equivalent relations of metonymy.

However, in our experimental setting only the instructor has a stable grammar for the object on his side throughout the construction dialogue, whereas the constructor, screened off from him, will develop such a grammar in (ideally monotonic) successive steps by the instructor's help. Finally, as shown in fig. 3, he will have acquired a grammar depicting airplanes.
At the end of the construction dialogue, we arrive at a situation where there exist two grammars, G_I and $G_{C,m}$, generating the "Baufix" airplanes at the instructor's and the constructor's side, respectively. All along the construction dialogue, the instructor's grammar has been a necessary condition for the constructor's building of his version of the airplane. Ideally, the two "Baufix" airplanes will cover one common extension, i.e., depict in the same way.



Description: $G_{C,j}$: different stages of constructor's grammar, G_I: invariant instructor's grammar, ▬ ▶: interpretation

Fig. 3: Constructor acquiring a grammar for depicting objects

3 Outlook

In our aproach we use *extensional* models for the definition of the meaning of depicting aggregates. Objects in the model domain are things in the world, namely real airplanes and their parts. We nevertheless aim at a *cognitive* interpretation of our theories. We see two ways of integrating cognitive aspects:
As for the first way, agents consider depicting objects as being segmentable into parts even if the objects are not put together from individual elements as "Baufix" toy planes are. There are natural segmentations corresponding to principles of object recognition as described, e.g., by Marr and Nishihara (1978). A cognitively motivated syntax may start out from such segmentations, e.g., from

segmentations into geons in the sense of Biederman (1987).
As for the second way, one may use concepts instead of things as objects of the model. Since concepts are not directly accessible, agglomerations of geometric figures may be used in their place (cf. arguments given in (Biederman, 1987)). Thus a relation is established between syntactic structure and concepts.
A further field of research is the examination of parameters of metonymy use in order to get at pragmatic constraints, dealing with questions such as: When are metonymic expressions introduced in dialogue? What is the profit gained from their use? One of the main profits we found out is the possibility of intrinsic orientation liberating from negotiating the meaning of 'up', 'in front', 'left', etc..
Further research in representation metonymy seems worth-while because of its widespread use in WIMP user interfaces. Intelligent agents supporting users of CASE or CAD/CIM systems will inevitably have to cope with depiction as well as with the step-wise construction of meaning in dialogue.

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